



The **Hazard Evaluation and Emergency Response (HEER) Office** is part of the Hawai'i Department of Health's Environmental Health Administration whose mission is to protect human health and the environment. The HEER Office provides leadership, support, and partnership in preventing, planning for, responding to and enforcing environmental laws relating to releases or threats of releases of hazardous substances.

Arsenic in Waiakea Pond: Ecological and Human Concerns

This fact sheet provides an overview of the potential ecological and human health concerns associated with arsenic in Waiakea Pond. Waiakea Pond is a 40-acre, spring- and stream-fed estuary in Hilo, Hawai'i that drains into Hilo Bay. The pond is tidally influenced with a maximum depth of approximately 12 feet. Swimming is not allowed in most areas of Waiakea Pond, however it is a popular area for recreational mullet fishing area. Other fish and crab are also taken for human consumption and Waiakea Pond is an important habitat for many birds.

What is arsenic and why is it in Waiakea Pond?

Arsenic is a naturally occurring element in the earth's crust. The natural background concentration of arsenic in volcanic soils in Hawai'i ranges from 5 milligrams per kilogram [mg/kg] to 25 mg/kg. This is roughly equal to a sand grain-sized nugget of arsenic in 1 to 5 double handfuls of soil. These concentrations of arsenic are below levels that pose a health risk to humans.

The presence of arsenic in the sediment of Waiakea Pond has been known for some time. Most of this arsenic is related to human activities and is not naturally occurring. The arsenic contamination comes from a mixture of sources, including a former canec plant and former sugar mill on the mauka edges of the pond plus erosion and runoff of soil from former cane fields in upland areas.

Wastewater contaminated with inorganic arsenic was discharged into Waiakea Pond from a canec plant that operated on the southeast corner of the pond from 1932 to 1963. Canec board was made from pressed waste sugarcane fiber and widely used for ceilings or walls in home and commercial buildings in Hawai'i (see *Arsenic in Canec Ceilings and Wallboard in Hawai'i* fact sheet). Inorganic arsenic was added to the canec as a termiticide. An estimated 500 tons of arsenic compounds were released into Waiakea Pond from the plant's sewer line on the east side of the pond.

Sodium arsenite (an inorganic arsenic compound) and other arsenic-based herbicides and pesticides were used in and around sugarcane fields in the Hilo area from the 1910s through 1940s. Sugarcane harvested from the fields was brought to a sugar mill that operated on the southwest side of the pond during this time period, where it was washed and then processed. Dirt washed from the cane likely contributed to arsenic contamination of sediments in the pond. Erosion and runoff of soil from former cane fields in upland areas contributed to impacts of pond sediment and continues to a lesser degree today.

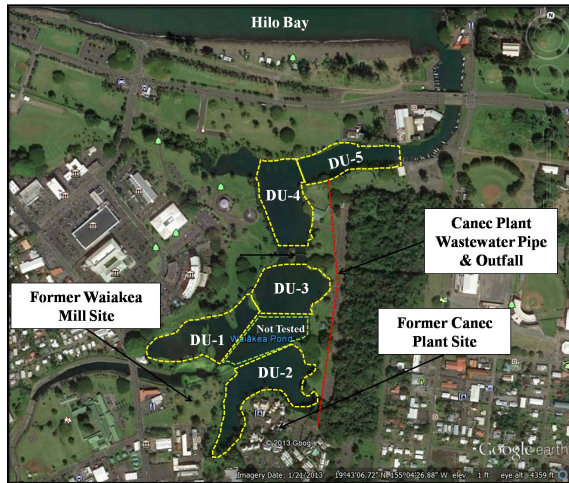


Does arsenic in the Waiakea Pond sediment pose a health risk?

Several, limited studies of arsenic in the sediment and biota of Waiakea Pond have been carried out over the past 30 years. From 2013 to 2015, HDOH conducted a more detailed study of Waiakea Pond in order to more carefully determine levels of arsenic in sediment, mullet, crabs and algae, and evaluate possible risk to humans and wildlife. A copy of the study report is available from the Department of Health HEER Office in Pearl City.

The study included testing of the top three layers of sediment in the pond for arsenic (0-4", 4-8" and 8-12"). Samples were tested for both inorganic arsenic and organic arsenic. Concentrations of >100 mg/kg total arsenic were reported for most of the sediment samples collected from the pond, indicating a significant increase above natural background. Almost all of the arsenic was the inorganic form. The highest total arsenic concentrations were reported for sediment located adjacent to the former cane plant. Deeper sediments near the former cane plant wastewater discharge pipe also had a high concentration of arsenic.

The reported concentrations of are far below any level that might pose immediate health concerns if a young child or adult accidentally ingested some of the sediment in a single episode. The concentrations were high enough, however, to raise initial concerns about repeated exposure to the sediment over many years. More detailed testing of the sediment was therefore carried out to determine the "bioaccessibility" of the arsenic. This determines the ability of the arsenic to leach from the sediment and into a person's body if small amounts of the sediment are swallowed. The test results indicated that the arsenic is too tightly bound to natural iron in the sediment to be released in the stomach or intestines in significant amounts. This means that the arsenic does not get absorbed in the body and is eliminated in feces with other components of the soil. This has also been found for elevated levels of arsenic in other soils associated with former sugarcane fields in the Hilo area. Arsenic in the pond sediment therefore does not pose a health risk to children and adults who regularly use the park.



TOP: Map of Waiakea Pond showing the location of the former sugar mill and cane plant as well as the wastewater pipe and outfall. For sampling purposes, the pond was divided into 5 sections (labeled as "DU"). Sediment from each area was sampled to determine arsenic levels related to the use of arsenic in the mill, plant and nearby cane fields in the early 1900s.



BOTTOM: Sediment sampling at Waiakea Pond.

Am I at risk if I eat fish or shellfish from Waiakea Pond?

Striped mullet (*Mugil cephalus*), Marquesan mullet (*Valamugil engeli*), snapper (*Lutjanus fulvus*), goatfish (*Mulloidides vanicolensis*), Hawaiian flagtail (*Kuhlia sandvicensis*), white crab (*Portunus sanguinolentus*) and the Samoan crab (*Scylla serrata*) are all found in Waiakea Pond. At least 25 bird species, including the endangered Hawaiian coot (*Fulica alai*) and the Hawaiian duck (*Anas wyvilliana*) have been documented at the pond.

HDOH collected and tested samples of mullet and crab from the pond as part of the study. The tests used the edible portion of the fish and shellfish to assess human health risk and to make advisory determinations.



Arsenic was measured in the tissue of striped mullet, Marquesan mullet, Samoan crab, and algae (*Melosira* species) in Waiakea Pond. Arsenic levels were compared with the same species collected from other locations in the islands that have not been impacted by arsenic contamination. These species were chosen to determine the potential effects from ingesting plants, fish, shellfish, and the incidental ingestion of sediments from Waiakea Pond.

Despite very high total arsenic and inorganic arsenic levels in sediments at Waiakea Pond, striped and Marquesan mullet species as well as crabs collected from Waiakea Pond and estuary did not have elevated levels of inorganic arsenic compared to natural, reference site locations. In addition, arsenic in shellfish and fish is primarily organic arsenic, a different chemical form than inorganic arsenic used at former sugar plantations, in cane board products and for wood treatment. Organic arsenic in fish and shellfish is not considered toxic to humans. Fish and shellfish taken from Waiakea Pond are therefore considered safe to consume. Arsenic was slightly elevated in samples of brown algae from the pond in comparison to algae from other ponds. While this species of algae is not known to be regularly consumed by humans, concentrations were within the range of arsenic typically found in algae (limu) in marine environments and are not considered to pose a significant health risk to anyone who might occasionally eat small amounts of the algae.

What are the human health concerns of arsenic exposure?

People who have been exposed to very high levels of arsenic over long periods of time have had health problems that include changes in skin pigmentation (dark spots), thickening or warts on the palms of the hands and soles of the feet, damage to heart and blood vessels, and inflammation of the liver. In addition, long-term exposure to high levels of arsenic has been associated with an increased risk of cancer.

Although elevated above natural background, levels of arsenic reported for sediment and algae in Waiakea Pond are not high enough to pose immediate or long-term health risks to park users. That said, it remains a good idea to practice good hygiene to minimize exposure to sediment and algae in the pond.

Is all arsenic absorbed in the human body?

Not all arsenic is available for absorption into the body if accidentally ingested. Only a certain portion, called the “bioavailable” arsenic fraction, becomes soluble and is taken up into the body, where it could pose a potential health risk. The fraction of bioavailable arsenic in soil (or sediment) is estimated by the use of a laboratory test referred to as the “SBRC gastric-phase assay.” The test estimates the amount of “bioaccessible” arsenic in the soil, or the amount of arsenic that would be accessible for uptake in the body if the soil was accidentally swallowed. Tests of arsenic-contaminated soil in Hawaii consistently indicate that the bioaccessibility, and therefore potential bioavailability, is very low. This is because the arsenic is tightly bound to naturally occurring iron in the soil. This helps to reduce risk posed by routine exposure to the soil.

Arsenic does not accumulate in the body (bioaccumulate). Stopping exposure will reduce arsenic levels in the body. For more information on arsenic bioaccessibility and testing, refer to the *Arsenic in Hawaiian Soils: Questions and Answers on Health Concerns* fact sheet.

How can I test to see if I have been exposed to arsenic?

Any arsenic exposure testing should be recommended and conducted by a doctor or trained medical professional. Tests are available to measure arsenic in your urine, blood, hair or fingernails. HDOH has not generally recommended human exposure testing in former sugarcane plantation areas. The urine arsenic test is considered the most reliable but can only determine exposure within the prior few days. The testing can



determine if the level of arsenic in the body is higher or lower than the average person. The testing cannot determine the origin of the arsenic (e.g. soil or food) or whether the arsenic levels in the body will affect the individual's health. Urine arsenic testing (by HDOH and the federal Agency for Toxic Substances Disease Registry [ATSDR]) of people living near two Hawai'i Island community gardens with elevated soil arsenic found normal arsenic levels in most individuals tested. The tests could not determine if higher inorganic arsenic exposures measured in some older individuals was from soil ingestion or their rice and seafood diets.

What can I do to minimize exposure to arsenic?

If testing reveals elevated levels of inorganic arsenic in urine or you are concerned about exposure to arsenic in the soil and sediment in and around Waiakea Pond, options for limiting exposure include:

- Keep children from playing in bare areas of soil around Waiakea Pond and from contacting sediment in the pond;
- Keep toys, pacifiers and other items that go into children's mouths clean;
- Wash hands and face thoroughly after visiting the pond area, especially before meals and snacks;
- Wash all fish and shellfish from Waiakea Pond to remove any remaining sediment particles before eating;
- Avoid eating algae (limu) from Waiakea Pond.

Further Information

For questions about this fact sheet or further information on HEER Office guidance related to soil arsenic, contact:

Hawai'i Department of Health,
Hazard Evaluation and Emergency Response Office
2385 Waimano Home Road, #100
Pearl City, Hawai'i 96782
Telephone: (808) 586-4249

To access more detailed information regarding soil arsenic, including detailed reports of studies conducted in Hawai'i and elsewhere, please visit the HEER Office website: <http://hawaii.gov/doh/heer>

Additional references located on HEER Office website:

Homeowner's Guide to Soil Testing for Arsenic HDOH, 2008.

Arsenic in Canec Ceilings and Wallboard in Hawai'i (Fact Sheet) HDOH, 2010.

Federal Government

To learn about recommendations from the Federal Government regarding arsenic, you can also contact the Agency for Toxic Substances and Disease Registry, ToxFAQs internet address <http://www.atsdr.cdc.gov/toxfaq.html>

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